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(51) INT CL[5]
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(56) Documents Cited
EP 0493893 A2 **EP 0454245 A2** **EP 0385128 A2**
US 4928301 A **US 4400725 A**

(58) Field of Search
UK CL (Edition L) **H4F FAA FCW FDX FJH FJL**
INT CL[5] **H04N 5/225 5/64 7/14**
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(54) **Video conferencing terminal**

(57) A video conferencing terminal has a liquid crystal display (50) for receiving and displaying images from a like terminal (55) and an image detection means (60) placed behind the display (50) for the detection of images to be transmitted to a like terminal (55). An image of the viewer (40) reaches the detector (60) through omitted pixels in the liquid crystal display after being collected by an optical fibre (200) and focused by a lens (180).

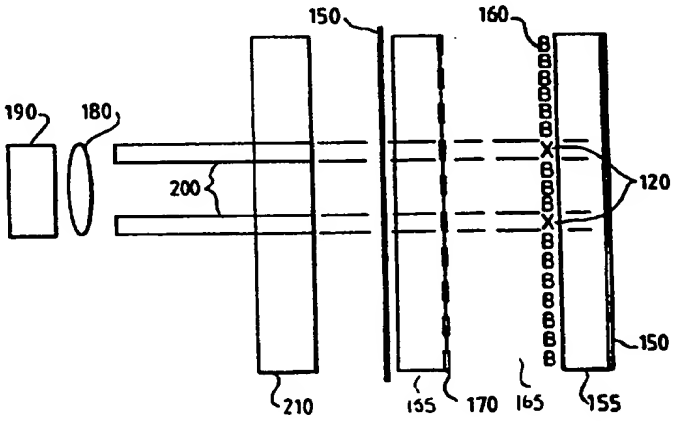

FIG. 5

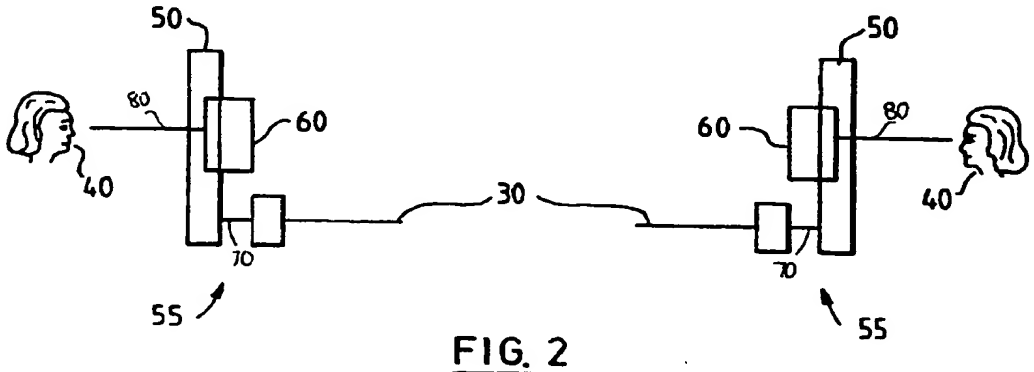

FIG. 2

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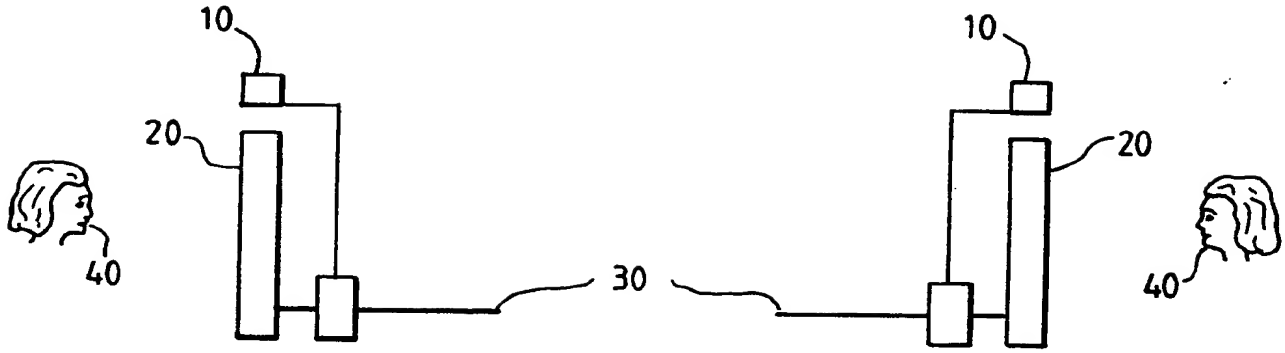

FIG. 1

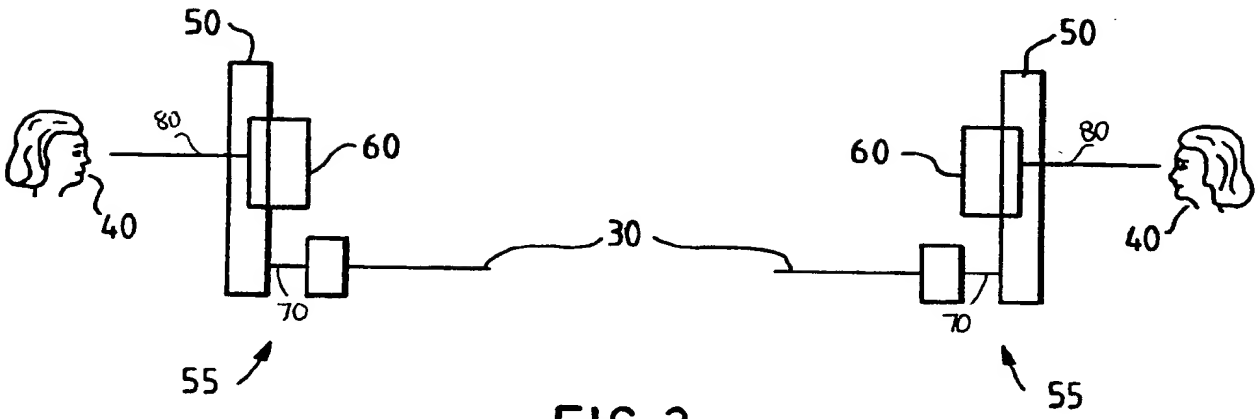

FIG. 2

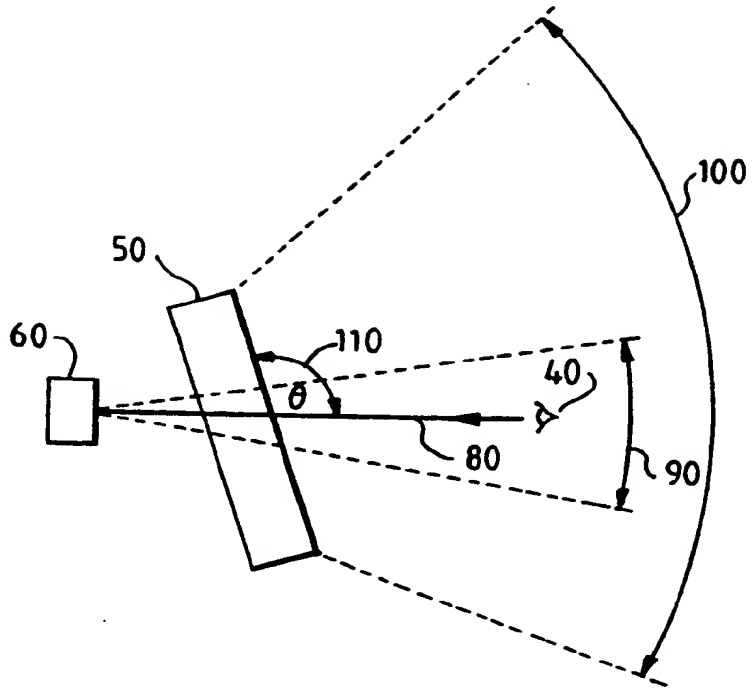

FIG. 3

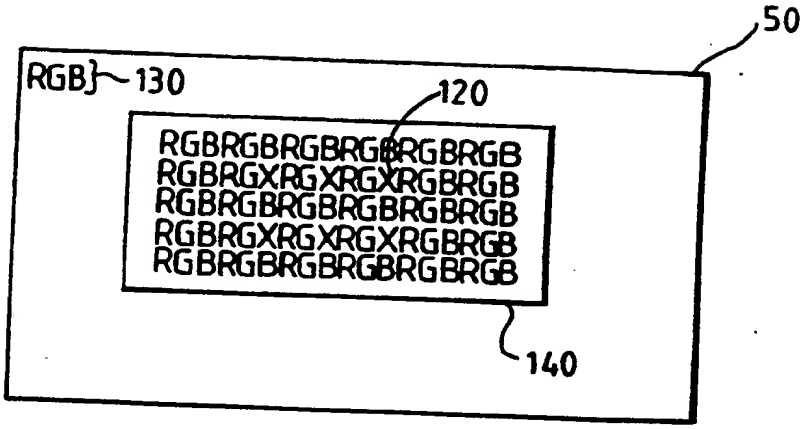

FIG. 4

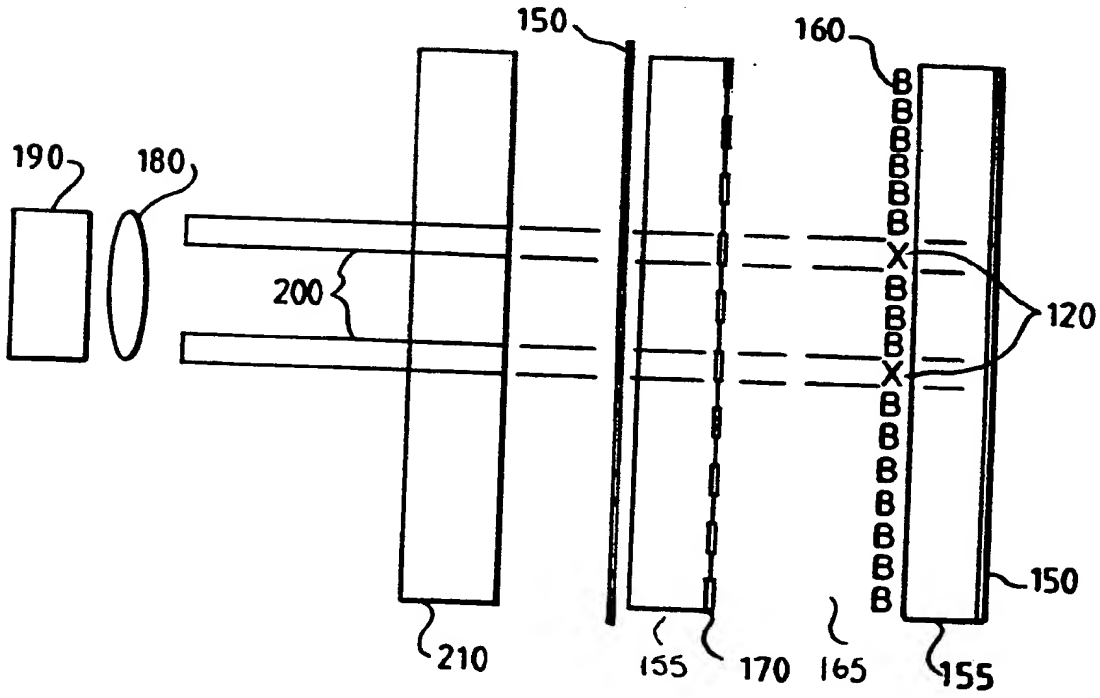

FIG. 5

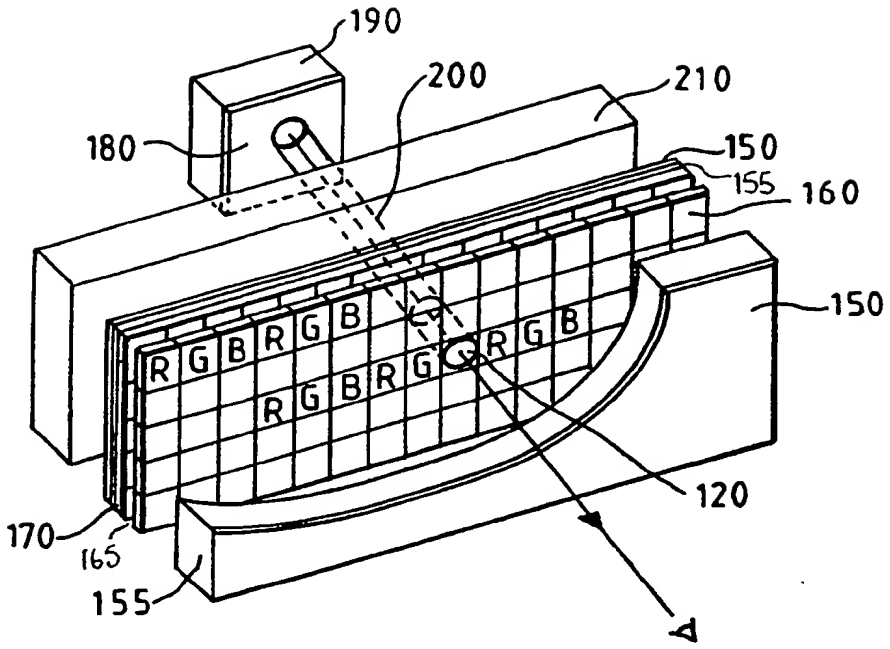

FIG. 6

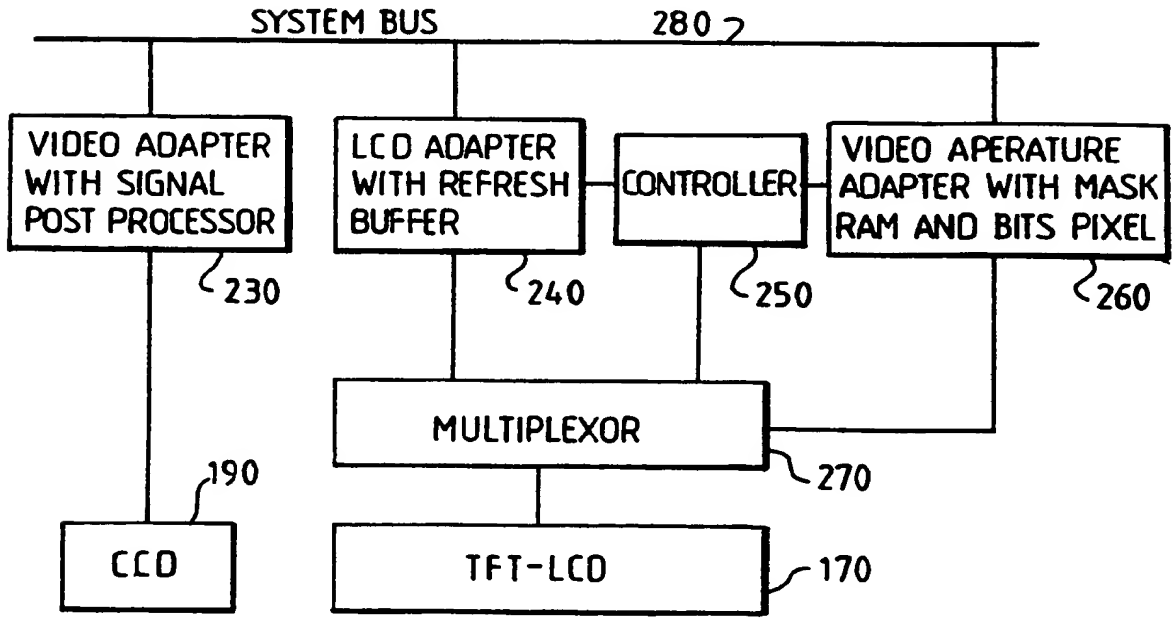

FIG. 7

A VIDEO CONFERENCING TERMINAL

DESCRIPTION

The invention relates to a video conferencing terminal for use in a video conferencing system which facilitates eye contact between user's by incorporating an image detection means.

It is well established practice to use, in a video conferencing system, a separate video display terminal and camera, or to incorporate the two into a single more manageable terminal, to facilitate video and voice communication between parties at remote locations. The outputs of such terminals, the voice and the image of the user of the terminal, being conditioned so as to be in a suitable form for transmission to a like terminal using an appropriate medium such as Integrated Services Digital Network (ISDN) or similar protocol.

Most video conferencing systems have the video camera mounted above the screen. Thus when the users look at the image on the screen, their image, as recorded by the camera, is one of a person looking downward. A complaint about video conferencing is that the participants appear depressed because they seem to always have their eyes downcast. In the absence of eye contact, video interactions have an unnatural quality which is not present in face to face conversations. In desk top conferencing systems which use conventional personal computer monitors and display the video image in a window, the problem is particularly apparent. The sought after improved eye contact would allow video conferencing users to evaluate more confidently their counterparts, and to participate more comfortably in exchanging information.

IBM Technical Disclosure Bulletin, Vol.35, No.2, July 1992 discloses a scheme to enable desk top video conferencing users to modify their system so that eye contact can be established between participants. Two mirrors, one half-silvered, are used to translate the apparent location of a screen image to directly in front of a camera which is capturing the user's image. The image can be adjusted in size and position. The disadvantage of such a system is the need to fit the apparatus to the monitor every time it is required and to subsequently remove it.

According to the present invention there is now provided a video

conferencing terminal comprising a liquid crystal display for receiving and displaying images from a like terminal and an image detection means for the detection of images to be transmitted to a like terminal, characterised in that the liquid crystal display screen is light permeable; the line of sight of the image detection means is collinear with a viewing angle of the liquid crystal display screen; the image detection means detects light incident on, and transmitted through, the face of liquid crystal display screen; and the field of view of the image detection means and the viewing field of the liquid crystal display screen are coincident.

A video conferencing terminal in accordance with the invention advantageously enables the users of the video conferencing system to establish eye contact without the need to add on to and subsequently remove additional apparatus for doing so.

In many instances the field of view of the image detection means may not exactly coincide with the viewing field of the liquid crystal display screen. In such circumstances the field of view of the image detection means and the viewing field of the liquid crystal display screen will be only partially coincident.

Suitably, the field of view of the image detection means and the viewing field of the liquid crystal display screen are either partially or wholly coincident in any particular embodiment of the invention.

A liquid crystal display is suitable for implementing the present invention due the structure and properties of the liquid crystal layer. In a liquid crystal display light enters the liquid crystal layer through a first polariser. The direction of polarisation of the light is rotated by the polymers therein. The light emerges from the other side of the liquid crystal layer via a second polariser.

Pixel elements are used to display information, written or pictorial, within a liquid crystal display screen. In the case of a colour liquid crystal display screen, three sub-pixels are required to form one colour pixel. Each sub-pixel having red, green and blue colour filters on a colour filter array. As each pixel element which is in the line of sight of the image detection means is utilised, the amount of light detected by the image detection means varies. Accordingly, it is necessary to vary

the sensitivity of the image detection means to compensate for the variation in light.

In accordance with one specific embodiment of the present invention the sensitivity of the image detection means is variable and synchronised to the state of at least one of the liquid crystal display screen pixels, such that the sensitivity of the image detection means is varied as the amount of light transmitted through the liquid crystal display screen pixel is varied.

It will be apparent to one skilled in the art that merely because the present invention relates to a video conferencing terminal utilising a colour liquid crystal display, this does not preclude the possibility of another embodiment of the present invention utilising a monochrome liquid crystal display. Similarly, notwithstanding a specific embodiment of the present invention described herein utilising thin film transistor liquid crystal display technology, the present invention is not limited to such technology. It can equally be implemented utilising other liquid crystal display technology, such as super twisted nematic liquid crystal displays.

For the purposes of the present invention an image detection means is not limited to a photosensitive device. It may be taken to comprise all or some of the elements which facilitate the detection of the user's image by providing an optical path between the user and the photosensitive device. Consequently, an optical fibre, or plurality thereof, collecting light which is incident on, then transmitted through, the face of an image display means and focused, via a lens, onto a charge coupled device is deemed to constitute, for the purposes of this invention, an "image detection means" or parts thereof.

In accordance with another embodiment of the present invention the image detection means comprises an optical series arrangement of at least one optical fibre, a light focusing means and a charged coupled device.

The colour filter array for a thin film transistor liquid crystal display can be designed with a number of omitted filters so that an area of the colour filter array is transparent. This allows light, incident on the face of the liquid crystal display screen, to be transmitted through the transparent area within the colour filter array where it is detected by

the image detection means. It has been noted, during human factors testing, that the eye is less sensitive to changes in blue luminance over a given area than it is to changes in red or green luminance. Therefore a limited number of blue sub-pixel filters may be omitted from the colour filter array without the user perceiving any substantial detriment in picture quality. However, this does not preclude the possibility of omitting other filters in addition to or instead of the blue sub-pixels filters.

Accordingly, in a further specific embodiment of the present invention there is provided a video conferencing terminal wherein one or more filters of the colour filter array are omitted thereby increasing the intensity of light propagating through the liquid crystal display screen and being detected by the image detection means.

It will apparent to one skilled in the art that an alternative embodiment of the present invention utilising an aperture immediately in front of the image detection means may improve the quality of the image detected. Suitably, the aperture may be created by not utilising a pixel or plurality thereof within the liquid crystal display screen and aligning the image detection means with the aperture. The pin hole camera thereby created has the further advantage of remaining in focus over the full field of view.

In a particular embodiment of the present invention there is provided a video conferencing terminal wherein the area of the liquid crystal display screen which would impede, wholly or partially, the field of view of the image detection means if utilised to depict an image, is not so utilised thereby creating an unobstructed field of view for the image detection means.

In a multi-party conversation, it is desirable to have all parties to the conversation simultaneously displayed. Such a system is realised if the images of the other parties to the conversation are displayed in separate video display windows rather than utilising the whole of the liquid crystal display screen. In order to establish eye contact between users, it is then necessary to translate the appropriate video display window, in which the parties' images are depicted, to selected areas of the liquid crystal display screen having an image detection means. The translation is achieved either under system control or under the control

of the parties to the conversation. Suitably, the user of the video conferencing terminal can utilise a conventional window translation means such as that in IBM Operating System/2 (IBM and Operating System/2 are trademarks of International Business Machines Corporation, Armonk, New York, U.S.A.).

Therefore, a video conferencing terminal in accordance with a further aspect of the invention advantageously comprises a plurality of image detection means; each image detection means having at least one corresponding video display window.

As the user of a video conferencing terminal can only establish eye contact with a single party at any one instant in time a single image detection means can be shared between a plurality of video display windows. Consequently a multi-party conversation can be realised utilising fewer image detection means than there are video display windows. The video display window, containing the image of the party with whom the user is conversing, is translated from its current position to an area of the liquid crystal display screen having an image detection means in the manner described above.

Appropriately, a video conferencing terminal, as described above, wherein an image detection means is shared between a plurality of video display windows and further comprising means for translating a video display window to a predetermined area of the liquid crystal display screen obviates the need for a one to one mapping between an image detection means and a video display window.

It will be apparent to one skilled in the art that an improvement in picture quality can be achieved if the image detection means is situated at or near the edge of a video display window. The state of the pixels at or near the edge of the video display window is less variable than those near the centre.

In accordance with another aspect of the present invention there is provided a video conferencing terminal wherein the image detection means is situated at or near the edge of a video display window.

The present invention may benefit from additional illumination of the user thereby increasing the intensity of the light reflected from the

user on to the liquid crystal display screen.

Consequently, in another embodiment of the present invention there is provided a video conferencing terminal further comprising means for illuminating the field of view of the image detection means.

In many instances it is desirable to have not only the image of the other party to the conversation displayed, but other applications software or its results simultaneously displayed. This can be achieved if the application and its results operate within a separate video display window.

Therefore, a video conferencing terminal in accordance with the invention may advantageously be utilised for the purposes of communication with minimum interference to other applications simultaneously using the liquid crystal display screen.

The invention will now be described, by way of example, with reference to the accompanying drawings in which:-

Figure 1 illustrates an existing video conferencing system according to the prior art.

Figure 2 illustrates a video conferencing system incorporating a video conferencing terminal according to the present invention.

Figure 3 illustrates a video conferencing terminal according to the present invention.

Figure 4 illustrates the basic structure of a liquid crystal display screen which is a suitable video display means for implementing the present invention.

Figures 5 and 6 illustrate a specific embodiment of a video conferencing terminal according to the invention.

Figure 7 illustrates a schematic system diagram of a video conferencing terminal according to the present invention.

In Figure 1 there is shown a video conferencing system according to the

prior art comprising a pair of video display terminals 20. Each video display terminal 20 depicts the image of the other party 40 to the conversation. Each video display terminal 20 having a camera 10 or other suitable image detection means for the purpose of capturing the image of the user 40 of that terminal. Both terminals are connected via a communication network 30. The video display terminals 20 utilise the communication network 30 for transmitting data to or receiving data from the other video display terminal 20.

In Figure 2 there is shown a video conferencing system according to the present invention comprising a liquid crystal display as the video display means. An image detection means 60 is incorporated within the liquid crystal display screen of the video conferencing terminal such that its line of sight 80 is normal to the user 40. The output of the image detection means 60 is a video signal 70. The video signal 70 after encoding by the system is transmitted over a communication network 30 to a like terminal 55. The like terminal 55 decodes the information received and displays the image of the other party.

Referring to Figure 3, there is shown schematically the relationship between the image detection means 60, the liquid crystal display screen 50, the line of sight 80 of the image detection means 60, the viewing angle 110 of the liquid crystal display screen 50, the viewing field 100 of the liquid crystal display screen 50 and the field of view 90 of the image detection means 60. It can be seen that in order to establish eye contact between the users 40 it is essential that the line of sight 80 of the image detection means 60 is substantially collinear with the line of sight of the user 40. That is, the line of sight 80 of the image detection means and the angle at which the user 40 is viewing the screen should substantially form a straight line. That angle is known as the viewing angle 110. There are an infinite number of viewing angles 110 over the viewing field 100 of the liquid crystal display screen 50. The viewing field 100 being the field over which the face of the liquid crystal display screen 50 can be observed. The field of view 90 of the image detection means 60 is coincident with the viewing field 100 of the liquid crystal display screen 50. This geometry allows the image detection means 60 to capture the user's 40 gaze normally i.e. establish eye contact with the user 40 of a like terminal 55.

The basic structure of a liquid crystal display screen 50 which is

suitable for implementing the present invention is shown in Figure 4. It will be noted that the "X"s represent omitted blue filters 120 of the normal sub-pixel filter 130 arrangement of Red, Green and Blue (RGB). In a specific embodiment of the invention, as shown in Figure 4, all of the omitted blue filters 120 are contained in a video display window 140 within which the image of the other party to the conversion will be depicted. It should be noted that for the purposes of the present invention other liquid crystal display screen pixel arrangements may be suitable.

In Figure 5 there is shown a cross section of a particular embodiment of a video conferencing terminal according to the present invention, illustrating the interrelationship between the omitted blue filters 120 and the other constituents of the video conferencing terminal. The liquid crystal display screen 50 comprises a first polariser 150, a substrate 155, a liquid crystal layer 165, a colour filter array 160 with some of the blue filters omitted 120, a thin film transistor array 170, a second substrate 155, a second polariser 150, a diffuser 210 having two embedded optical fibres 200, a lens 180 and a charge coupled device 190. Light from the image of the user 40 passes through the first polariser 150, the substrate 155 and the aperture in the colour filter array 160 created by the omitted blue filters 120. The light then propagates through the liquid crystal layer 165, the thin film transistor array, the second substrate 155 and out through the second polariser 160. The optical fibre 200 is the light collecting element of the image detection means. The optical fibre 200 guides the light emerging from the second polariser 150 through the diffuser 210 to a lens 180. The lens 180 focuses the light onto a charge coupled device 190.

Referring to Figure 6, there is shown a cut-away perspective view of a specific embodiment of a video conferencing terminal according to the invention. For the purposes of clarity, an embodiment having only one optical fibre 200 is depicted whereas another embodiment of the invention may utilise a plurality of optical fibres 200. The line of sight 80 of the image detection means 60 corresponds to that of the optical fibre 200. The optical fibre 200 guides light, via a lens 180, to the charge coupled device 190. The end of the optical fibre 200 is aligned with the aperture created by the omitted blue filters 120.

The optical fibre 200 is embedded into the diffuser 210 and aligned with

the omitted blue filter(s) 120 thereby collecting light propagating through the liquid crystal display screen 50 from the user 40. The diffuser 210 is side-lit on all four sides to reduce the shadowing effects of the optical fibre 200. The image from the optical fibre 200 is focused, via a lens 180, onto one or more charge coupled devices 190, or other suitable photosensitive devices.

In Figure 7 there is shown a system diagram for a video conferencing terminal according to the present invention comprising a video adapter 230 coupled to the output of the charge coupled device 190. The video adapter 230 shares a common bus 280 with a liquid crystal display adapter 240 and a video aperture adapter 260. The signals from a controller 250, liquid crystal display adapter 240 and the video aperture adapter 260 are coupled to the thin film transistor array 170 via a multiplexer 270.

The amount of light reaching the image detection means 60 is controlled by the video aperture adapter 260. The video aperture adapter 260 has an area of refresh random access memory which can be addressed by the system. The control signals from the video aperture adapter 260 to the liquid crystal display screen 50 are multiplexed with the signals from liquid crystal display adapter 240 on a sub-pixel basis.

The video signal is processed as a group of sub pictures. Each image depicted will comprise many sub-pictures which have been merged by the video adapter 230 to produce a smooth windowed video picture.

The number of pixels displayed will be greater than the number of optical fibres 200 embedded into the diffuser 210.

The video image is then coded for transmission to a like terminal 55 over an ISDN or other suitable communication network 30. Whereupon, after decoding, the video signal 70 is transferred, via the system, to an appropriate video display window 140 within the liquid crystal display screen 50. It may be necessary to scale the images within the liquid crystal display screen 50.

It will be apparent to one skilled in the art that an alternative embodiment of the present invention could utilise a very small beam splitter or half-silvered mirror incorporated into the front of the image display means. The beam splitter or half-silvered mirror being coupled

to a transparent waveguide leading to the charge couple device or other suitable photosensitive device. This arrangement would allow light from the liquid crystal display screen to pass through the beam splitter or half-silvered mirror in one direction but deflect light incident from the opposite direction towards an image detection means.

CLAIMS

1. A video conferencing terminal comprising a liquid crystal display for receiving and displaying images from a like terminal (55) and an image detection means (60) for the detection of images to be transmitted to a like terminal (55) characterised in that the liquid crystal display screen (50) is light permeable; the line of sight (80) of the image detection means (60) is collinear with a viewing angle (110) of the liquid crystal display screen (50); the image detection means (60) detects light incident on, and transmitted through, the face of liquid crystal display screen (50); and the field of view (90) of the image detection means (60) and the viewing field (100) of the liquid crystal display screen (50) are coincident.

2. A video conferencing terminal as claimed in claim 1 wherein the field of view (90) of the image detection means (60) and the viewing field (100) of the liquid crystal display screen (50) are partially coincident.

3. A video conferencing terminal as claimed in claim 1 wherein the field of view (90) of the image detection means (60) and the viewing field (100) of the liquid crystal display screen (50) are wholly coincident.

4. A video conferencing terminal as claimed in any preceding claim wherein the sensitivity of the image detection means (60) is variable and synchronised to the state of at least one of the liquid crystal display screen pixels, such that the sensitivity of the image detection means (60) is varied as the amount of light transmitted through the liquid crystal display screen pixels is varied.

5. A video conferencing terminal as claimed in any preceding claim wherein the image detection means (60) comprises an optical series arrangement of at least one optical fibre (200), a light focusing means (180) and a charge coupled device (190).

6. A video conferencing terminal as claimed in any preceding claim wherein one or more filters of the colour filter array (160) are omitted thereby increasing the intensity of light propagating through the liquid crystal display screen (50) and being detected by the image detection

means (60).

7. A video conferencing terminal as claimed in any preceding claim wherein the area of the liquid crystal display screen (50) which would impede, wholly or partially, the field of view (90) of the image detection means (60) if utilised to depict an image, is not so utilised thereby creating an unobstructed field of view (90) for the image detection means (60).

8. A video conferencing terminal as claimed in any preceding claim having a plurality of image detection means (60); each image detection means (60) having at least one corresponding video display window (140).

9. A video conferencing terminal as claimed in any preceding claim wherein an image detection means (60) is shared between a plurality of video display windows (140) and further comprising means for translating a video display window (140) to a predetermined area of the liquid crystal display screen (50).

10. A video conferencing terminal as claimed in any preceding claim wherein the image detection means (60) is situated at or near the edge of a video display window (140).

11. A video conferencing terminal as claimed in any preceding claim further comprising means for illuminating the field of view (90) of the image detection means (60) thereby increasing the intensity of the light incident on the liquid crystal display screen (50).

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number
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Relevant Technical fields

(i) UK Cl (Edition L) H4F FAA FCW FDX FJH FJL

(ii) Int Cl (Edition 5) H04N 5/225 5/64 7/14

Search Examiner
D H JONES

Databases (see over)
(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

Date of Search
1 MARCH 1993

Documents considered relevant following a search in respect of claims 1-11

Category (see over)	Identity of document and relevant passages		Relevant to claim(s)
X	EP 0493893 A2	(AT & T) see Figure 1	1-4
X	EP 0454245 A2	(PHILIPS) see Figure 1	1-4
X	EP 0385128 A2	(ALCATEL) see Figure 1	1-4
X	US 4928301 A	(BELL) see Figure 6	1-4
X	US 4400725 A	(TANIGAKI) see Figure 3	1-4

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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